

# An Interdisciplinary Infection Control Education Intervention: Necessary But Not Sufficient

DIANNE P. WAGNER, MD, FACP  
CAROL J. PARKER, MPH  
BRIAN E. MAVIS, PhD  
MARY KAY SMITH, MSN, RN

## Abstract

**Background** Patient care environments are struggling to eradicate health care associated infections and studies of undergraduate and graduate medical trainees have revealed significant gaps in their performance of proper hand hygiene and aseptic technique (HH/AT), suggesting the need for improved curriculum. High-reliability industries have provided a model using standardization of approach and interprofessional training, and both are particularly suited to the teaching and assessment of these life-saving skills. The Infection Control Education project is a grant-funded, multi-institutional pilot launched to improve the teaching and assessment of HH/AT in our community.

**Methods** An interprofessional team of leaders and educators from 2 local hospital systems and 3 health colleges developed a 9-component “ICE PACK,” which includes a unanimously endorsed, detailed HH/AT checklist. This teaching and assessment module was

delivered to nursing/medical student and postgraduate year 1 resident/nurse intern pairs. Retention of checklist skills was retested 2 to 5 months after participation in the module.

**Results** Learner pairs participating in the 2-hour module mastered the HH/AT checklist and rated the experience highly. Retention after several weeks was disappointingly low in 2 of the 3 participant groups.

**Conclusions** A community-wide HH/AT checklist was developed and an ICE PACK of materials created that is portable, standardizes the teaching and assessment of HH/AT skills, and is designed for interprofessional pairs of learners. Retention of checklist steps was disappointing in most of participant groups. Multiple, simultaneous strategies for improving compliance with infection control mandates appear necessary.

## Background

Ambulatory and inpatient care environments are struggling to enhance hand hygiene practices to contribute to eradicating health care associated infections (HAIs). Health care workers' compliance with hand hygiene and aseptic technique (HH/AT) is a key component of this effort.<sup>1</sup> The

Joint Commission has announced the prevention of HAIs as a major patient safety goal.<sup>2</sup> Efforts such as the Michigan Health and Hospital Association Keystone Intensive Care Unit initiative have established the benchmark to which we must strive—a median of zero HAIs in the intensive care unit.<sup>3</sup> Although large-scale efforts to attain this goal are ongoing at the “sharp end” of actual patient care in both inpatient and ambulatory environments, studies of the efficacy of educational curricula and HH/AT learning outcomes have produced variable results.<sup>4,5</sup> At Michigan State University, medical students at the end of their required clerkship year performed an average of 62% of the required checklist items when asked to set up a sterile field before a joint aspiration (unpublished data). At 2 Michigan institutions, new postgraduate year 1 (PGY-1) trainees from both United States and international medical schools demonstrated significant performance deficits in HH/AT at the beginning of residency.<sup>4,5</sup>

Until recently, the education of health care professionals across the continuum has predominantly focused on knowledge, with the assessment of skills and attitudes being far less sophisticated or consistent. As the Accreditation Council for Graduate Medical Education and, increasingly, the Liaison Committee on Medical Education have

All authors are at Michigan State University. **Dianne Wagner, MD, FACP**, is Associate Professor of Medicine and Associate Dean for College Wide Assessment in the College of Human Medicine; **Carol Parker, MPH**, is Executive Director, Graduate Medical Education Inc, and Director of Continuing Medical Education in the College of Human Medicine; **Brian Mavis, PhD**, is Associate Professor and Director, Office of Medical Education Research and Development in the College of Human Medicine; and **Mary Kay Smith, MSN, RN**, is Coordinator of Simulation Operations in Learning and Assessment Center and Instructor in College of Nursing.

Acknowledgments are given to The Blue Cross Blue Shield Foundation of Michigan for their generous funding and the membership of the Lansing Patient Safety Initiative.

Funding: The authors report no external funding source.

Corresponding author: Dianne P. Wagner, MD, FACP, A102 East Fee Hall, Michigan State University, East Lansing, MI 48824, wagnerd@msu.edu

Received June 29, 2010; revisions received August 26, 2010 and December 3, 2010; accepted December 21, 2010.

DOI: 10.4300/JGME-D-10-00120.1

**BOX INFECTION CONTROL EDUCATION (ICE) OBJECTIVES****Knowledge**

- Know major findings of the Institute of Medicine's report "To Err is Human"
- Know principles of fail-safe team
- Know impact of hospital-acquired infections on patient morbidity and mortality
- Know principles of asepsis
- Know steps in process of exemplary hand hygiene
- Know steps in process setting up sterile field
- Understand principles of error commission in health care

**Skills**

- Perform exemplary hand hygiene using soap and water wash
- Perform exemplary hand hygiene using alcohol rub
- Correctly set up sterile field for patient procedure
- Communicate effectively with team member
- Demonstrate receptivity to feedback from team member
- Demonstrate receptivity to feedback from skill rater

**Attitudes**

- Receive feedback on performance with open mind
- Value contributions of health care team members when caring for patients

emphasized learner evaluation, undergraduate and graduate health professions schools have required that trainees "know how," "show how," and actually "do" what they previously only had to "know."<sup>6,7</sup> These performance-based assessments have revealed new evidence about learners' skills and the gaps in the educational continuum.<sup>8</sup> Advocates for improving patient safety education have called for standardization of approach and team training to be woven into health professions education.<sup>9,10</sup> Recommendations further stress that "teaching should be undertaken in an interdisciplinary fashion and capitalize on...application of simulation as a teaching tool."<sup>11</sup> Adding new curricular material to an overcrowded program is challenging. When the curriculum requires not only new knowledge but psychomotor skills and a change in attitude it is even harder.

Data from both the Michigan State University College of Human Medicine Care of Patients objective structured clinical examination given to students at the end of their undergraduate medical education year 3 and the PGY-1 Patient Safety objective structured clinical examination have revealed a significant gap in trainees' HH/AT skills.<sup>4</sup> A review of the undergraduate curriculum and assessment of both HH/AT was informative and showed that the curriculum emphasized fact-based testing with little to no practice or assessment of the multiple required psychomotor steps. Faculty role modeling and the presence of a hidden curriculum that deterred hand hygiene practices decrease the likelihood that learners will attain proficiency. An interdisciplinary approach focused on team training, which is standard in high-reliability industries like aviation and nuclear power, provided a model for improving this situation, as aseptic technique at the bedside is often

performed by multidisciplinary teams of providers. The Infection Control Education (ICE) project was born. The ICE project is a grant-funded, multi-institutional effort launched to improve the teaching and assessment of HH/AT in our community. This article describes the development and implementation of this pilot project.

**Methods**

A grant proposal was submitted to the Blue Cross Blue Shield Foundation of Michigan in response to a request for applications aimed at increasing safety in the ambulatory care environment. The proposal called for the development and pilot testing of a teaching and assessment module covering the knowledge, skills, and attitudes required for exemplary HH/AT. The Foundation funded the project. A subcommittee of the multi-institutional Lansing Patient Safety Initiative,<sup>12</sup> which seeks systems-solutions to patient safety problems in the Lansing, Michigan community, formed the advisory group for this initiative, provided institutional leadership, and shared responsibility for program implementation. Several meetings determined the knowledge, skills, and attitudinal competencies desired of participants and discussed instructional design considerations. Experts in infection control and nursing education from each participating institution created the final skills checklist. Because this checklist was to become the community standard, it is quite detailed and includes each psychomotor step in the processes of HH/AT as well as team skills components. We utilized multiple educational modalities (PowerPoint presentation, live demonstration, pretesting and posttesting) within the module and created a teaching video of the correct procedures and technique "bloopers" featuring key hospital leaders. Short video clips demonstrating problematic behaviors have been shown to be an effective means of improving compliance with aseptic technique,<sup>13</sup> and hospital leaders' participation provided a strong message of their commitment to this effort. Our self-contained curriculum module, named the "ICE PACK," includes the following components:

1. Required knowledge/skills/attitudes document (see BOX)
2. HH/AT checklist created using Centers for Disease Control and Prevention and Joint Commission guidelines and the combined expertise of staff and faculty from all cooperating Lansing Patient Safety Initiative institutions. This checklist was created and vetted by nursing and medical staff and faculty in the Colleges of Osteopathic Medicine, Human Medicine, and Nursing as well as Edward W. Sparrow Hospital, Ingham Regional Medical Center, and the Michigan State University Health Team (University's faculty group practice). The checklist was intentionally team-focused to illustrate the fail-

	Yes	No
1. Team verifies the patient's identity using two identifiers		
2. Team verifies that the patient understands the planned procedure and signs consent form when appropriate		
3. Team obtains appropriate equipment and/or supplies and checks expiration date(s)		
4. Team members cleanse hands at the beginning of the procedure		
a. If hands are not visibly soiled, cleanse with alcohol rub		
1. No artificial nails		
2. Dispense alcohol rub		
3. Completely cover hands		
4. Rub hands together vigorously with friction under nails until dry		
b. If hands are visibly soiled, wash hands with soap and water		
1. No artificial nails		
2. Pre-dispense paper towels		
3. Turn on faucets		
4. Dispense soap		
5. Completely cover hands		
6. Rub hands together vigorously 15 seconds with friction under nails		
7. Rinse thoroughly with hands pointed downward		
8. Dry with paper towel		
9. Turn off faucet with paper towel		
5. Team member verifies the correct side and site for the procedure		
6. Team member places procedure appropriate pad under the patient in the appropriate location		
7. Team member applies protective mask/eyewear/bonnet (if indicated)		
8. Team member cleanses hands with alcohol rub		
9. Team member dons sterile gown(s) and gloves		
a. Remove sterile gown from outer package and place on surface, such as over bed table or procedure stand.		
b. Open wrap containing sterile gown by farthest edge first, closest edge last touching only outer one inch		
c. Open outer wrap of sterile gloves and drop inner wrap onto sterile field without touching with bare hands.		
d. Put on sterile gown placing arms into sleeves but not all the way through cuffs		
e. Second team member assists by pulling gown over shoulders and arms		

FIGURE

INFECTION CONTROL EDUCATION (ICE) CHECKLIST

	Yes	No
and tying neck tie		
f. Open inner sterile glove wrap touching only outer one inch.		
g. Leaving hands on inside of gown, grasp dominant hand sterile glove with dominant hand		
h. Place palm of glove onto palm of dominant hand		
i. Grasp bottom of cuff with fingers of dominant hand		
j. While still covered by sterile gown, non dominant hand grasps cuff and pulls over dominant hand		
k. Gloved dominant hand grasps remaining sterile glove from field		
l. Place palm of glove onto palm of non dominant hand		
m. Pull remaining glove over non dominant hand		
n. Adjust fingers of both gloves as necessary		
o. Keeps hands in front and above waist. Doesn't touch anything outside the sterile field		
p. If present, tie waist tie. Second team member assists by grasping waist tie with sterile gloves, wrapper or drape to remain sterile. First team member makes 3/4 turn and secures at front of gown OR second team member may tie at back if sterile gloved.		
10. Team members open supplies correctly and place them on field maintaining aseptic technique		
a. Check all items for integrity and expiration dates (if app.)		
b. Second team member may open outer packaging as first team member places items onto sterile field		
c. Team members prevent sterile field from becoming wet, cut or torn (if wet, cut, or torn, begin again)		
d. All sterile items are kept within outer inch of sterile field		
e. Team members limit talking throughout		
h. Team members face field at all times		
11. Team members communicate to keep the patient informed throughout procedure		
12. Team verifies the correct side and site for the procedure		

FIGURE

CONTINUED

safe team concept in this setting and is now the community-wide standard for educating trainees (see FIGURE )

3. Educational PowerPoint explaining core principles; key learning objectives of the PowerPoint included information on common types of medical errors, error prevention strategies, the scope of HAI morbidity and mortality, principles of asepsis, and principles of a fail-safe team

4. Trainee demonstration of exemplary HH/AT in the setting of a sterile procedure
5. Video of exemplary HH/AT and re-enacted "bloopers" created using hospital and college leadership; this demonstrated ideal performance and common errors
6. Pre-post test of knowledge relevant to infection control and team functioning
7. Evaluation form for participants (see TABLE 1)

TABLE 1 PARTICIPANT EVALUATION FORM: RESPONSE SUMMARIES

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)	Mean Rating
1. The pretest-posttest was an effective learning tool.	0	2	4	21	6	3.9
2. The PowerPoint presentation was an effective learning tool.	0	2	2	23	6	4.0
3. The black light hand-washing exercise was an effective learning tool.	0	0	1	9	23	4.7
4. The faculty demonstration of hand-washing and aseptic technique was an effective learning tool.	0	0	7	11	10	4.1
5. The practice with a health team partner was an effective learning experience.	0	0	0	12	21	4.6
6. The check off with a health team partner was an effective learning experience.	0	2	0	10	21	4.5
7. I found this module helpful in learning exemplary hand hygiene.	0	1	1	12	19	4.5
8. I found this module helpful in learning aseptic technique.	0	1	2	12	18	4.4
9. I will be able to translate what I learned during this module to my daily patient care.	0	1	0	15	17	4.5
10. I feel more confident in my hand hygiene because of this module.	0	3	2	11	17	4.3
11. I feel more confident in the performance of aseptic technique because of this module.	0	3	1	12	17	4.3
12. This module will help me provide better patient care.	0	1	2	11	19	4.5

8. ICE pin and certificate of participation were developed using ICE logo

9. Postparticipation Web survey (see TABLE 2)

Pairs of trainees participated in the 2-hour module using ICE PACK materials and activities. First-year nursing students were paired with third-year medical students, and PGY-1 residents were paired with newly hired nurse interns. This simulated a real procedure set-up as it occurs in a patient care setting and placed nursing and medical trainees in a situation where shared learning and coaching might take place. The nursing and medical students are at similar points in their training with respect to real patient contact. The nursing students are in the third year of their undergraduate curriculum, having been admitted to the College of Nursing after introductory course work to begin their clinical rotations. The medical students are in their required clerkship year and have previously had only limited real patient contact. The PGY-1 residents and the nurse interns have made the transition from their undergraduate environment to significantly increased patient care responsibility. A pretest and posttest was used to assess knowledge and attitudes related to the didactic component of the module. To assess learners' skills, participants were

required to demonstrate their ability to set up a sterile field. Partial task trainers of the knee and shoulder were used (knees for undergraduate medical education and shoulders for graduate medical education participants) to provide realistic scenarios for sterile field set-up before a joint aspiration. All necessary supplies were available, and alcohol rub was used for hand hygiene. The last step in the module was observation of the learner pairs by a physician or nurse faculty member to confirm compliance with HH/AT techniques using the HH/AT checklist previously described. All participants achieved 100% compliance as part of completing the training. Additional training was immediately available to pairs unable to achieve 100% compliance at their initial observation. All participants rated the module using the participant evaluation form developed by the ICE committee.

Three groups of learners were retested: College of Human Medicine medical students participated in a patient care objective structured clinical examination at the end of their third year that includes an HH/AT station where they must set up a sterile field and demonstrate correct HH/AT. The College of Nursing students and PGY-1 residents used the same partial task trainers and equipment used in the initial training and redemonstrated the skills required on the

TABLE 2 INFECTION CONTROL EDUCATION (ICE) MODULE FOLLOW-UP QUESTIONNAIRE

			N	%
1.	Did you have experience with aseptic technique prior to taking part in the ICE module?	No	1	8
		Yes	12	92
2.	How would you rate your first performance in the ICE module?	Fair	0	0
		Adequate	7	54
		Good	6	46
3.	Completing the ICE module with a health team partner was an effective learning experience.	Disagree	3	23
		Neutral	0	0
		Agree	10	77
4.	How helpful was the feedback from the nurse for improving your skills related to aseptic technique?	Not very	2	15
		Somewhat	6	46
		Very	5	39
5.	In thinking about the feedback you received about correct technique, how consistent was the feedback with aseptic technique practices you have witnessed in clinical settings?	Not very	5	39
		Fairly	4	31
		Very	4	31
6.	Since first taking part in the ICE module, how many times have you witnessed health care professionals use those same aseptic techniques in clinical settings?	0 times	1	8
		1–2 times	3	23
		3–4 times	1	8
		5 or more	8	62
7.	Since first taking the ICE module, how many times have you had an opportunity to practice those aseptic technique skills?	0 times	1	8
		1–2 times	3	23
		3–4 times	1	8
		5 or more	8	62
8.	How many more times do you think you would need to practice aseptic technique before you would feel confident?	0 times	5	39
		1–2 times	5	39
		3–4 times	1	8
		5 or more	2	15

checklist with a nurse observer. The interval between module participation and retesting was 2 months for the PGY-1 residents, 4 months for the nursing students, and 5 months for the medical students.

The project was approved by the Institutional Review Boards of Michigan State University, the Edward W. Sparrow Hospital, and the Ingham Regional Medical Center.

## Results

Thirty-four participants completed the aseptic technique training module. Working in interdisciplinary teams of 2 or 3 learners, 13 first-year nursing students were trained with 10 third-year medical students, and 5 PGY-1 residents were trained with 6 new nurse interns. For knowledge related to aseptic technique, the mean pretest

score was 51% while the mean posttest score was 63% (TABLE 3); this increase in knowledge was statistically significant ( $t = 5.82$ ,  $df = 33$ ,  $P < .001$ ). There were no statistically significant differences across the 4 learner groups. Fourteen participants took part in follow-up knowledge retesting approximately 2 to 5 months after the initial training. The mean knowledge scores for this subset of participants was 52% (median = 55%) at pretest, 63% (median = 65%) at posttest, and 57% (median = 55%) at follow-up.

All participants achieved 100% on the HH/AT skills checklist as part of the initial training. At follow-up retesting with 14 participants, the mean checklist performance was 59% and varied from 38% for the nursing students and residents to 86% for the third-year medical students.



TABLE 3 PRETEST, POSTTEST, AND RETEST KNOWLEDGE SCORES BY PARTICIPANT GROUP

Participant Group	Pretest Mean Score, %(N)	Posttest Mean Score, %(N)	Retest Mean Score, %(N)
Nursing students (year 1)	47 (13)	60 (13)	61 (4)
Medical students (year 3)	48 (10)	63 (10)	no retest
Residents (PGY-1)	56 (5)	66 (5)	54 (5)
Nurse interns	58 (6)	68 (6)	no retest
All participants	51 (34)	63 (34)	57 (9)

Abbreviation: PGY-1, postgraduate year 1.

Program satisfaction was measured at the conclusion of the ICE module. The aggregate responses are presented in TABLE 3. The overall mean satisfaction rating across all items and participants was 4.4 on a 5-point scale. There was no difference in overall satisfaction across the respondent groups.

A follow-up Web-based survey was distributed after retesting; 13 participants (38%) completed the questionnaire after 3 requests (TABLE 2). Most respondents agreed that the module was an effective learning experience (77%) and that the nurse feedback was helpful for skills development (85%). In comparing the skills feedback in the module to their experience in clinical settings, a significant proportion of respondents (70%) reported some degree of inconsistency. Informal comments revealed frustration by the mismatch between what trainees had been taught in the ICE module and what was common practice in their learning environments.

## Discussion

A multidisciplinary, multi-institutional work group developed an ICE teaching and assessment module to impart the knowledge, skills, and attitudes that would improve trainee performance of HH/AT. Team concepts were included in the design of the ICE PACK components. A great deal of interinstitutional discussion and collaboration was necessitated by this effort, and a great deal of light was shed on the barriers that exist to the development of coherent and effective curriculum and assessment of these “taken for granted” skill sets. Scheduling problems were paramount and created challenges to interinstitutional and interdisciplinary education that strained members’ commitment to the project and delayed implementation. The presence of the grant funds and associated responsibilities kept the group moving on the project, though some deadlines were not met, and 2 no-cost extensions were necessary and granted. In the end, fewer modules and retests than we had hoped to schedule were completed. We were able to retest each “type” of learner: nursing students, undergraduate medical students, and PGY-1 residents. These barriers to multi-

institutional and interdisciplinary learning and assessment require system-wide solutions that simplify logistics and enable learners from different disciplines to learn from and about each other.

Our study has several limitations. The final checklist was not validated; studies of its effectiveness in providing differential performance results for different levels of learners were not done and will be an important next step in refining and validating our approach. However, the Lansing Patient Safety Initiative committee agreed that all learners in clinical environments should be held to the same standard for HH/AT without consideration for their level of training as this is a critical component to preventing HAI. Also, while the checklist was created with expert resources and local expert opinion and was agreed upon by multiple institutions, portions of it are not strictly related to either hand hygiene or aseptic technique. Other safety procedures germane to the ambulatory or inpatient environments were added such as “time outs” and patient identification procedures. These elements add to its length. Our year-long pilot study also is limited by the small number of participants. Although the study takes place in a single community, our community contains 2 hospital systems and 3 health professions colleges.

## Conclusions

We created an ICE teaching and assessment module to address gaps in HH/AT performance of nursing and medical trainees at multiple institutions. A community-wide HH/AT checklist was developed and an ICE PACK of materials created that would enable deliverability by almost any teacher and portability of the module to almost any environment.

The teaching and assessment module was uniformly well received by all participants, even residents from a procedure-heavy specialty several months into their training. Retesting 2 to 5 months later revealed variable retention of elements of the checklist, and comments from participants shed light on the hidden curriculum that decreases the effectiveness of any single response/intervention to address a performance gap. Our learners experience a training hierarchy that makes it difficult to speak up and the time pressure that all providers

face, as well as the fact that effective curriculum and assessment of HH/AT was not a feature of every mentor's education.<sup>14</sup> It has been said that "culture eats strategy for lunch."<sup>15</sup> Many aspects of health professions' educational and practice cultures decrease the likelihood that trainees will be afforded appropriate teaching, adequate practice, and sensible assessment of HH/AT competencies. We employed the strategies of standardization and team training to improve competence and encourage culture change.

Our ICE module provides an effective foundation for addressing educational and performance gaps around HH/AT. Possible next steps for the Lansing Patient Safety Initiative institutions include information technology-enabled "Just In Time"<sup>16</sup> learning and assessments of trainees' knowledge, skills and attitudes, mandated and repetitive observed practice, stealth observation of trainees, the identification of champions within practices and hospital units, and curricular changes within our health professions schools and the faculty group practice.

The ICE PACK module is simple to administer, self-contained, and portable and engages teams of health professions learners at any point in their training in an effective simulated experience. It utilizes multiple educational strategies that result in an increase in knowledge and the attainment of critical HH/AT skills. The ICE PACK provides a solution to the identified curricular and assessment gap demonstrated by our learners. This module can be tailored to any setting where the standardized, interdisciplinary teaching and assessment of HH/AT competencies is desired.

## References

- 1 Joint Commission. Joint Commission infection control initiatives. Available at: [http://www.jointcommission.org/topics/patient\\_safety.aspx](http://www.jointcommission.org/topics/patient_safety.aspx). Accessed August 26, 2010.
- 2 Joint Commission. Joint Commission national patient safety goals. Available at: <http://www.jcrinc.com/National-Patient-Safety-Goals/>. Accessed August 26, 2010.
- 3 Pronovost P, Needham D, Berenholtz S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med*. 2006;26(355):2725-2732.
- 4 Wagner DP, Hoppe RB, Lee CP. A patient safety OSCE for PGY-1 residents—a centralized response to the challenge of culture change. *Teach Learn Med*. 2009;21(1):8-14.
- 5 Lyson ML, Frohna JG, Gruppen LD, Wooliscroft JO. Assessing residents' competencies at baseline: identifying the gaps. *Acad Med*. 2004;79(6):564-570.
- 6 ACGME Outcomes Project. Enhancing residency education through outcomes assessment. 2000. Accessed on May 9, 2011 at <http://www.acgme.org/Outcome/>
- 7 Miller GE. The assessment of clinical skills/competence/performance. *Acad Med*. 1990;65:63-67.
- 8 Wagner DP, Lyson, ML. Centralized assessment of core competencies: cents and sensibilities. *J Grad Med Educ*. 2009;01(01):pp21-27.
- 9 Cohen, JJ. Behold the patient-safety genie. *Acad Med*. 2000;75(2):105.
- 10 Kohn LT, Corrigan JM, Donaldson MS, editors. *To Err Is Human: Building a Safer Health System*. Free Executive Summary, Committee on Quality of Health Care in America, Institute of Medicine, National Academy of Sciences, 2000. Accessed on May 9, 2011 at [http://www.providersedge.com/ehdocs/ehr\\_articles/To\\_Err\\_Is\\_Human\\_%20Building\\_a\\_Safer\\_Health\\_System-exec\\_summary.pdf](http://www.providersedge.com/ehdocs/ehr_articles/To_Err_Is_Human_%20Building_a_Safer_Health_System-exec_summary.pdf)
- 11 Lucian Leape Institute. Unmet needs: teaching physicians to provide safe patient care. Available at: [www.npsf.org](http://www.npsf.org). Accessed March 29, 2010.
- 12 Wagner D, Lee CP. The Lansing Patient Safety Initiative. Paper presented at: National Patient Safety Foundation National Meeting; May 2008; Nashville, TN.
- 13 Xiao Y, Seagull FJ, Bochicchio GV, et al. Video-based training increases sterile-technique compliance during central venous catheter insertion. *Crit Care Med*. 2007;35(5):1302-1306.
- 14 Guzzo JL, Seagull FJ, Bochicchio GV, et al. Mentors decrease compliance with best sterile practices during central venous catheter placement in the trauma resuscitation unit. *Surg Infect (Larchmt)*. 2006;7(1):15-20.
- 15 Collins, J. *Good to Great*. New York, NY: HarperCollins; 2001.
- 16 Ferenchick G, Feters M, Carse AM. Just in time: technology to disseminate curriculum and manage educational requirements with mobile technology. *Teach Learn Med*. 2008;20(1):44-52.